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Originals

Aneuploidy in *Thelypteris laxa* (Franch. & Sav.) Ching (Thelypteridaceae)

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Chromosome number of *Thelypteris laxa* was determined, and two cytotypes, 2n=136 and 2n=134 were found. The former cytotype is regarded as tetraploid based on x=34, and the latter as aneuploid (hypotetraploid) of the former. In Japan, the hypotetraploid seems to have a wider distribution range than the eutetraploid.

Thelypteris laxa is distributed in Japan, Korea (Cheju Isl.), southern China and Taiwan. In Japan it is common in warm temperate regions, occurring mainly in lightly shaded places in lowlands (Iwatsuki 1995). Preceding chromosomal works have shown that this species has two basic chromosome numbers, x=34 and 36; the former was suggested from mitosis in root tip cells as 2n=136, and the latter from meiosis in spore mother cells as n=36, 36IV or 72 (see Table 1). As to Japanese plants, Kurita (1963) reported n=72 (x=36) from Kikugawa, Shizuoka Pref., while Nakato (1996) counted 2n=136 (x=34) from Tsukubasan, Ibaraki Pref. In this paper, I intend to report the results of a further chromosomal survey on plants from 19 localities in Japan, including a new aneuploidal cytotype which widely occurs.

Materials and Methods

Localities of materials are listed in Table 1. Plants were collected from native habitats, and cultivated in pots. For the observation of somatic chromosomes, root tips were put in 0.002 M 8-hydroxyquinoline for 4 hours, and fixed in 45% acetic acid for 10 minutes. The fixed roots were macerated with 1N HCl for 1 minute at 60°C, and squashed in 2% aceto-orcein solution. The number of spores per sporangium was counted to ascertain whether reproduction was sexual or apogamous. Voucher specimens are deposited in TI (the Botanical Gardens, University of Tokyo).

Results and Discussion

Chromosome number Chromosome numbers were determined in 24 plants from 19 localities in Japan (Table 1). Of these, 3 plants from 2 localities were found to be 2n=136, and the remaining 21 plants from 17 localities were 2n=134 (Figs. 1 & 2). The plants of 2n=136 and those of 2n=134 were indistinguishable morphologically.

The basic chromosome numbers available so far in the genus *Thelypteris* sensu Iwatsuki (1995) are diverse and are reported to be x=27, 30, 31, 32, 34, 35 and 36 (Takamiya 1996). The 2n=136 cytotype of *T. laxa* could safely be regarded as tetraploid based on x=34, agreeing with the observations of Nakato (1996), and the 2n=134 cytotype, newly found in this study, as aneuploid (hypotetraploid) of the former. Chromosome numbers based on x=36, which was reported by Kurita (1963), Tsai and Shieh (1983) and Weng (1985), were not encountered during the course of this study.

Occurrences of aneuploids in a certain species have been often confirmed in various

Table 1. Chromosome numbers of *Thelypteris laxa* (Franch. & Sav.) Ching

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Chromosome number / Ploidy and basic chromosome number presumed
  Locality / Reference or voucher specimen (Nakato's No.)

- Previous study
  - n=72, tetraploid of x=36
    - Kikugawa, Shizuoka Pref. (Kurita 1963)
  - n=36IV, tetraploid of x=36
    - Lienhuachih, Nantou, Taiwan (Tsai and Shieh 1983, 1985)
  - n=36, diploid of x=36*
    - Hangzhou, Zhejiang, China** (Weng 1985)
  - 2n=136, tetraploid of x=34
    - Tsukubasan, Ibaraki Pref. (Nakato 1996)
- Present study
  - 2n=136, tetraploid of x=34
    - Sayama, Higashiyamato-shi, Tokyo Pref., no. 2081**
    - Umegaya-toge, Ome-shi, Tokyo Pref., nos. 2142**, 2143
  - 2n=134, hypotetraploid of x=34
    - Hagurosan, Haguro-machi, Yamagata Pref., no. 2131**
    - Mizuho-machi, Nishitama-gun, Tokyo Pref., no. 2097
    - Hinode-machi, Nishitama-gun, Tokyo Pref., no. 1976
    - Hinohara-mura, Nishitama-gun, Tokyo Pref., nos. 1978, 1979**
    - Takao-san, Hachioji-shi, Tokyo Pref., nos. 2068, 2069
    - Hatsukari-machi, Otsuki-shi, Yamanashi Pref., no. 2216
    - Tatsuruhama-machi, Kashima-gun, Ishikawa Pref., no. 1932**
    - Shika-machi, Hakui-gun, Ishikawa Pref., no. 2226
    - Yugashima, Amagiyugashima-machi, Shizuoka Pref., nos. 2035**, 2036
    - Funabara, Amagiyugashima-machi, Shizuoka Pref., nos. 2062**, 2063
    - Yadokoro, Owase-shi, Mie Pref., no. 2125
    - Ouga, Shingu-shi, Wakayama Pref., no. 2105
    - Hikimi-cho, Mino-gun, Shimane Pref., no. 2149**
    - Mochidagaura, Hakata-ku, Fukuoka-shi, Fukuoka Pref., no. 2113
    - Ikeda, Sawara-ku, Fukuoka-shi, Fukuoka Pref., no. 2127
    - Kumano, Bungotakada-shi, Oita Pref., no. 2218
    - Fukata, Usuki-shi, Oita Pref., no. 2222

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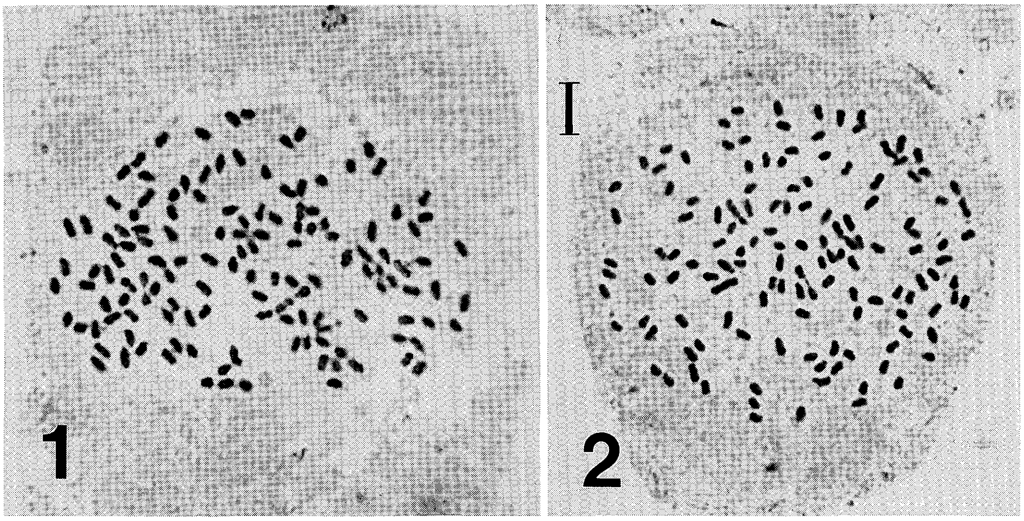
* Octaploid (x=9) in the original paper. But n=36 should be assigned to diploid, because species with n=9 or 18 have not been reported in this genus.

** Specimens examined for the number of spores per sporangium. All these have 64 good spores in a sporangium.

families and genera in Japanese ferns: *Isoetes japonica* A.Br. and *I. sinensis* T.C. Palmer in Isoetaceae (Takamiya et al. 1994), *Lepisorus thunbergianus* (Kaulf.) Ching in the Polypodiaceae (Nakato et al. 1983), *Pteris cretica* L. in Pteridaceae (Nakato 1989), etc. In these species, aneuploids have been found rarely in euploid populations and/or in restricted areas. On the contrary, in *T. laxa*, the hypotetraploids (2n=134) seem to have a wider distribution range than the eutetraploid (2n=136). The hypotetraploids may have advantageous attributes that caused these extensive distribution beyond the eutetraploids.

Comparison of chromosome length between the two cytotypes Although strict karyo-



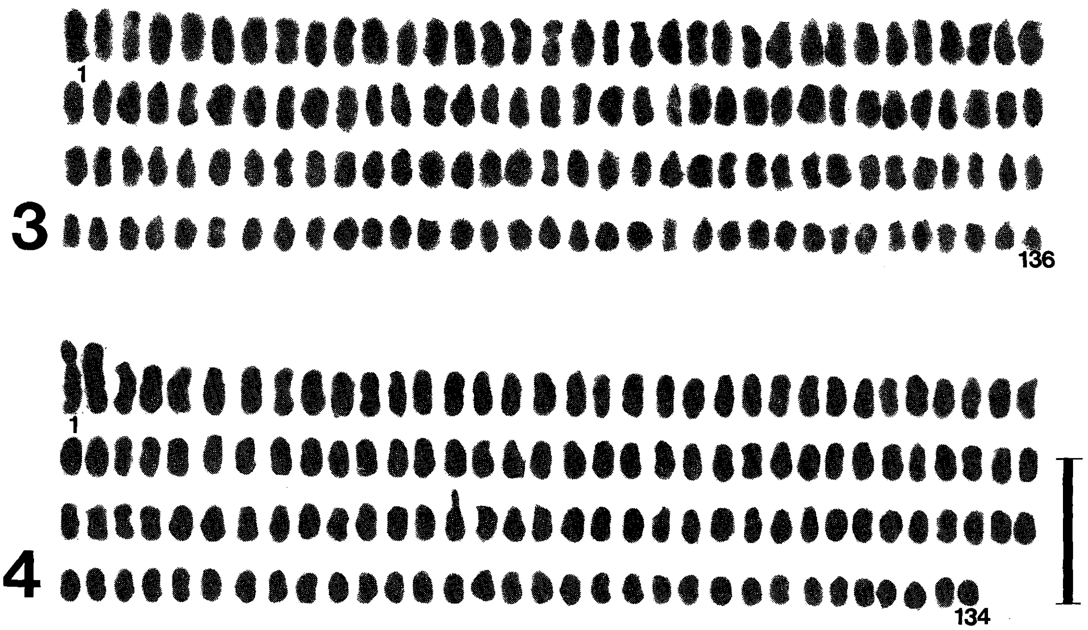
Figs. 1, 2. Somatic chromosomes of *Thelypteris laxa*. 1. 2n=136, eutetraploid, no. 2142. 2. 2n=134, hypotetraploid, no. 1978. Scale bar = 5 μm.

logical analysis was difficult from nuclear plates obtained in this study, the sizes of chromosomes could be measured and compared between those of the eutetraploid and the hypotetraploid. Figures 3 and 4 show somatic chromosome complements arranged by length, each corresponding to those of Figs. 1 and 2, respectively.

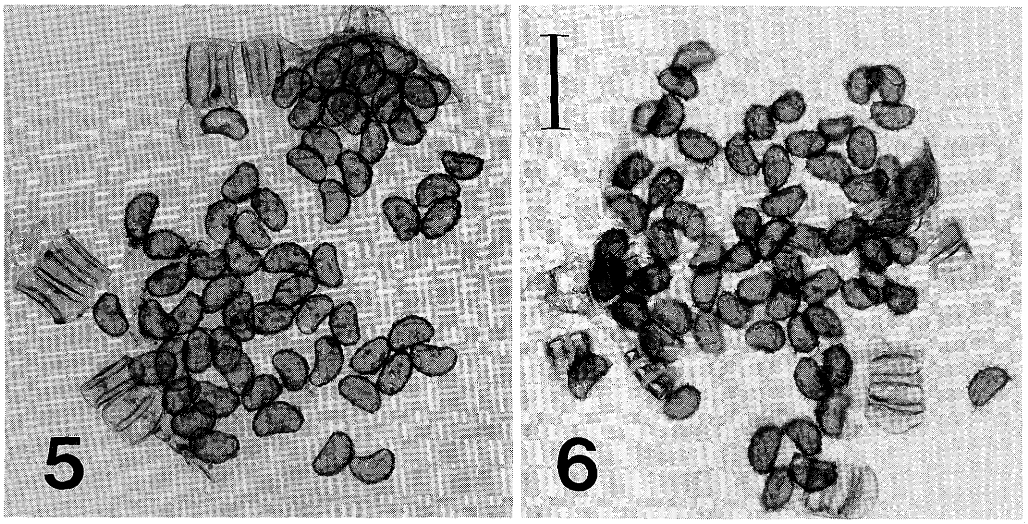
In the eutetraploid of no. 2142 (Fig. 3), the variation in chromosome length was gradual; the chromosomes range in length from 1.9 μm to 0.9 μm with the mean of 1.3 μm; and the longest chromosome was about 2.1 times as long as the shortest. On the contrary, in the hypotetraploid of no. 1978 (Fig. 4), the first two chromosomes were much longer than the others, being 2.4 μm in length; the remaining chromosomes showed a gradual decrease in length from 1.8 μm to 0.9 μm; the mean length of all chromosomes was 1.2 μm; and the length of the longest chromosomes was about 2.4 times that of the shortest. The two larger chromosomes were also observed in the complements of other hypotetraploids. These results suggest the possibility that reduction of chromosome number in the hypotetraploid might not arise from simple loss but from fusion of chromosomes.

Reproductive system The spore numbers per sporangium could be counted in 2 plants of the tetraploid and 6 plants of the hypotetraploid. In all of these specimens, 64 good spores were counted in each sporangium, indicating that they are sexual in reproduction (Figs. 5 & 6). This finding is in accordance with Momose (1967) from the studies of prothallia.

Cytotaxonomy of T. laxa and related species Iwatsuki (1995) classified the genus *Thelypteris* (37 spp.) of Japan into eight subgenera and eight sections and placed *T. laxa* in subgenus *Thelypteris*, section Metathelypteris, together with *T. gracilescens* (Blume) Ching, *T. uraiensis* (Rosenst.) Ching and *T. hattorii* (H. Ito) Tagawa. This section is referable to the genus *Metathelypteris* recognized by Ching (1963). The diagnostic characters of this group are: free veins, indusiate sori, absence of aerophore, veinlets that do not reach the margin of segments, and bipinnatifid to tripinnatifid fronds. Other Asian species allied to *T. laxa*



Figs. 3, 4. Somatic chromosome complement arranged by length. 3. 2n=136 chromosomes from Fig. 1, no. 2142. 4. 2n=134 chromosomes from Fig. 2, no. 1978. Scale bar = 5 μm.



Figs. 5, 6. Sixty-four spores in one sporangium. 5. Eutetraploid, no. 2142. 6. Hypotetraploid, no. 2131. Scale bar = 100 μm.

are *T. adscendens* Ching, *T. decipience* Ching, *T. flaccida* Ching and *T. singalanensis* Ching (Ching 1963, Iwatsuki 1965).

Among these species, the following four species have been examined cytologically: *T. flaccida* (n=35 and n=70, Manton and Sledge 1954), *T. singalanensis* (n=70, Manton 1954), *T. uraiensis* (n=62, Hirabayashi 1969; n=36IV, Tsai & Shieh, 1983) and *T. laxa* (see Table 1). From these data, it is assumed that the section Methathelypteris sensu Iwatsuki (1995) (or the genus *Metathelypteris* sensu Ching, 1963) is characterized by polybasic chromosome numbers such as x=31, 34, 35 and 36. These clearly show that aneuploidy as well as polyploidy has played an important role in the evolution of this group.

As stated earlier, *T. laxa* is distributed widely in warm temperate areas of E. Asia. However, data available from outside Japan are only those recorded by Tsai and Shieh (1983, 1985) and Weng (1985), each based on a single material from Taiwan and China, respectively, and reporting the base number of x=36. It is noted that Tsai and Shieh (1983, 1985) reported the number of n=36IV (36 quadrivalents) at meiosis with the normal production of 64 spores per sporangium. Extensive chromosomal studies, especially from outside Japan, are needed to understand the cytological evolution in this species.

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中藤成実：ヤワラシダの異数性

ヤワラシダにはx=34の4倍体，およびx=36の2倍体と4倍体が報告されている．今回，日本の19産地から採取した24個体について染色体を観察したところ，2産地からの3個体は2n=136，17産地からの21個体は2n=134であった．前者はx=34の正4倍体，後者は異数体で低4倍体と考えられる．本研究においてはx=36に基づく染色体数は観察できなかった．正4倍体と低4倍体の染色体の長さを測定したところ，正4倍体では136の染色体長は漸次変化するが，低4倍体では134の染色体のうち2本の染色体が特に長かった．このことから，低4倍体は正4倍体から単純に2本の染色体が欠失したものではなく，正4倍体の染色体が融合したために生じたのではないかと推察された．岩槻（1995）はヤワラシダを，Thelypteris亜属Metathelypteris節に分類した．この仲間の染色体数は現在までヤワラシダを含め4種で調べられており，染色体基本数についてx=31，34，35，36，倍数性では2倍体と4倍体が知られている．これは，この仲間の細胞学的進化には倍数性ばかりでなく異数性が重要な役割を演じたことを示している．

(東京都立国分寺高等学校)

第73巻2号　正誤　Errata in Vol. 73 No. 2

頁(Page)	行(Line)	誤(For)	正(Read)
104	↑ 18	trilobed or	trilobed to
106	↓ 2	var. *himalaica* Hara	var. *himalaica* H.Hara
108	↑ 4	(Hayata ex Honda)	(Hayata)
108	↑ 6	Hayata ex Honda	Hayata in Honda
108	↓ 18	Hayata ex Honda	Hayata
109	↓ 22	Hayata ex Honda	Hayata
110	↓ 10	Nakai ex Honda	Nakai in Honda
111	↑ 6	(Nakai) Hara	(Nakai) H.Hara
111	↑ 16	(Nakai) ex Honda	Nakai in Honda
111	↑ 21	Thunb.[8] ex Murray	Thunb.[8] in Murray
112	↑ 24	Nakai ex Honda	Nakai
113	↑ 24	*Heloniopsis*	*Heleniopsis*
114	↑ 15	ヤマシマショウジョウバカマ	ヤクシマショウジョウバカマ